

PATENT SPECIFICATION

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(54) METHOD AND APPARATUS FOR ADJUSTING THE COLOUR PURITY OF A COLOUR PICTURE DISPLAY TUBE

- (71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2., a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- 10 The invention relates to a method and apparatus for adjusting the colour purity of a colour picture display tube the screen of which is provided with phosphor dots of luminescent materials which when impinged upon by electron beams luminesce in different colours, the neck of the tube being provided with colour purity adjusting means and a deflection unit for deflecting the electron beams, at least one electron beam being energised during the adjustment to cause the screen to luminesce without any picture content.
- 15 The screen of the colour picture display tube most commonly used at present, the shadow mask tube, includes a large number of phosphor dots which luminesce in the colours red, green and blue when they are impinged upon by electron beams and which constitute triplets which are groups of three dots each of which luminesces in one of these three colours. An apertured shadow mask is provided behind the screen and the number of apertures therein is one third that of the number of dots. The triplets, the apertures in the mask and the three electron guns are placed in such a manner that each phosphor dot is impinged upon by the relevant electron beam. However, to compensate for the various tolerances in the tube, use is made of colour purity adjusting magnets which are provided around the neck of the tube. These adjusting magnets may be formed by two annular rotatable permanent magnets with which both the direction and the intensity of a magnetic correction field may be adjusted. It is alternatively possible to use coils for this purpose, through which coils adjustable currents flow, or to use a combination of magnets and coils. With either coils or magnets it is ensured that each electron beam originates from the correct deflection point and therefore lands on the phosphor dots of the relevant colour. When the purity is correctly adjusted, a white raster is visible on the screen when the dots are equally energised without any picture content.
- 20 In the publication "Philips Product Note No. 5": "Colour Purity Adjustment" two methods have been described for adjusting the purity, namely the microscope method and the red-ball method. In the first-mentioned method the location of the spot triplets are observed with the aid of a microscope and an auxiliary light source. These triplets are constituted by the landing on the screen of the electron beams and they are observed relative to the phosphor dot triplets in the middle of the screen when a white raster is produced with correct positioning of the purity magnets.
- 25 In the red-ball method the deflection unit which combines the vertical (field) and the horizontal (line) deflection coils is moved away as far as possible from its correct position on the neck of the display tube so that mislanding is produced away from the centre of the screen. By causing only the "red" electron gun to scan a raster, a red ball or circle surrounded by faulty hues is produced on the screen. The adjusting procedure consists in adjusting the colour purity magnets in such a manner that this ball or circle is moved to the centre of the screen. Subsequently the deflection unit is returned to its correct axial position and is
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secured there so that a more or less correct landing on the entire screen is effected.

It is to be noted that in order to counter the detrimental effect of the isotropic astigmatic deflection coils on the landing at the ends of the central lines of the screen, namely the disturbance of the equilateral shape of the triangles constituted by the phosphor dot triplets, the landings and the phosphor dots in the centre of the screen are not adjusted concentrically to each other in some types of tubes. To this end the construction of the picture tube is sometimes such that the landings are "compressed" towards each other in the centre of the screen so that a satisfactory landing with as much tolerance as possible is obtained at the ends of the axes and especially at the edges of the screen. For this reason the red ball is not adjusted relative to the centre of the screen in this case, but in the 8 O'clock direction with the upper end of the shorter axis of the tube considered as the 12 O'clock position. All this has been described in the above mentioned publication.

In practice the microscope method is not often used. Not only is a microscope with securing means to the face of the tube necessary for this purpose, but it is usually impossible for one man to look through the microscope and simultaneously adjust the magnets on the neck of the tube. In addition this method cannot easily be used for tubes in which the impinging electron beam is wider than the phosphor dot, which dot may be surrounded by an absorbing material. Such a picture tube is described in United States patent specification 3,146,368.

The red-ball method is fairly generally used because it does not require a microscope and because one man may perform this adjustment method with the aid of a mirror. However, this method is not accurate. The alignment of the fairly blurred ball in the centre of the screen without any further auxiliary means is not very exact and manufacturing tolerances of the picture tube may cause serious errors in the resultant adjustment because it is not effected at the correct axial position of the deflection unit. These errors may even render it impossible to correctly adjust some picture tubes, which of themselves are satisfactory.

The present invention relates to an adjusting method by which the above drawbacks may be obviated, that is to say, may be more accurate than the red-ball method and which may also be used for tubes in which the electron beam is wider than the phosphor dots.

The present invention provides a method of adjusting the colour purity of a colour picture display tube the screen of which is provided with phosphor dots of luminescent

material which when impinged upon by electron beams luminesce in different colours, the neck of said tube being provided with colour purity adjusting means and a deflection unit for deflecting the said electron beams, said method entailing the energising of at least one electron beam to illuminate said screen without any picture content, a pole of a device providing a magnetic field being placed on the face of said screen, said purity adjusting means being adjusted in such a manner that an area of the screen luminesces in the colour corresponding to the energised electron beam or beams in a previously determined position within the field.

The invention also provides apparatus for performing the method according to the invention which apparatus is simple and cheap and includes a source which provides a direct current to a coil and which may also include a thermistor having a positive temperature coefficient and a switch through which the coil may be arranged in series with the thermistor. The series arrangement so formed may be fed by an alternating voltage source.

In order that the invention may be readily carried into effect, some embodiments thereof will now be described in detail, by way of example with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a front elevational view of a picture tube including a device required for the method according to the invention,

Figure 2 is a sectional side view of the picture tube of Figure 1,

Figures 3 and 4 show the effect of the device of Figure 1,

Figure 5 shows the mutual situation of a phosphor dot triplet and a landing triplet in the centre of the screen of a picture tube employing "pre-compression",

Figure 6 shows an electron beam when the known red-ball method is used, Figure 7 is a front elevational view of a picture tube in a further embodiment of the method according to the invention,

Figure 8 is a sectional plan view of the picture tube of Figure 7,

Figure 9 shows a circuit diagram of apparatus for the method according to the invention, while

Figure 10 shows a circuit diagram of apparatus for performing the method according to the invention.

As is shown in Figure 1, a substantially circular thin coil of wire 2 having a diameter greater than its winding depth is adjusted in front of the screen 1 of a colour picture tube the axis of which coil coincides with that of the tube. Coil 2 is kept in position by means of a jig or is suspended from the upper rim of the cabinet of a colour

television receiver incorporating the picture tube to be adjusted. The coil may alternatively be secured by any other suitable manner. Connections 3 of coil 2 are connected to a supply voltage apparatus not shown in Figure 1, so that a direct current i determined by the resistance of the coil flows through coil 2, for example, into the direction which is shown in Figure 1. The supply apparatus may of course alternatively be a current source. As a result the landing of the electron beam is not influenced in the centre of the screen, but elsewhere it is influenced. This may be clarified with reference to Figure 2, showing the picture tube in a side-elevational view. Coil 2 generates a magnetic field some of the lines of force of which are shown in Figure 2 in the direction which corresponds to the current direction in Figure 1, which field is circular and symmetrical relative to a terminal axis which coincides with the axis of coil 2. Coil 2 is so thin relative to its diameter that one side thereof generates a North pole and the other side generates a South pole, one of these poles engaging the substantially flat screen. The reference numeral 4 denotes one electron beam which is generated by an electron gun and is deflected by the deflection unit d which is substantially in its correct position and which electron beam subsequently passes through an aperture in the shadow mask. When the electron beam comes in the above-mentioned field it is deflected again thereby. The result is shown in Figure 3. The electron paths undergo a rotation in the field generated by coil 2 so that mislandings occur and more of them occur as the distance to the centre from the coil increases. Figure 3 shows that the displacement obtained is effected in the same direction as that of current i , if this is reversed, the displacement of course also reverses its direction. The electron beams and the lines of force of the field are substantially parallel (Figure 2) in the vicinity of the centre C of the screen so that the movement of the electrons is hardly influenced.

When operating only the "red" electron gun under the conditions required for that gun for the production of a white raster a red ball is produced around the centre of coil 2, that is to say, the centre of the screen 1 if the purity magnets and/or purity coils p (Figure 2) are correctly adjusted. This is shown in Figures 4a and 4b. Figure 4a shows a "red" phosphor dot R, that is to say, a dot luminescing red light when it is impinged upon by electrons and which is located near the centre of the screen. Since the field generated by coil 2 does not substantially exert any influence at this area, the electron beam coincides substantially concentrically with the phosphor dot. Figure 4b shows a triplet of three phosphor dots R, G, B, of red, green and blue luminescent materials, respectively, which are mutually arranged as is shown in the Figure as seen from the front face of the picture tube. The triplet in Figure 4b is provided on screen 1 within coil 2 in the upper left quadrant relative to the centre, for example, at point M of Figure 3. As a result of the above-mentioned rotation, the electron beam now lands such that it is not concentric with dot R, but is displaced as shown in Figure 4b. Thus this triplet luminesces in the colour magenta (purple). Other triplets may be considered in the same manner. For example, in the other upper quadrant the colour displayed is green instead of red and in the lower quadrant it is blue.

The part of the screen where no mislanding occurs, i.e. the red ball, is comparatively small so that the correct adjustment of the purity is much more accurate than in the previously known red-ball method. Coil 2 itself or a substantially circular line 5 (see Figures 1 and 3) provided within coil 2 may function as a centring template for this purpose. Alternatively a cross or the like may indicate the centre of coil 2, for example, on transparent paper. It may be noted that even if coil 2 or line 5 are not satisfactorily centred relative to the centre of the screen, this has a negligible influence on the adjusting accuracy, for an eccentricity of 1 cm of the coil causes a deviation of approximately 5 microns in a picture tube having a diagonal of 25 inches (63 cms) and a deflection angle of 90° while a phosphor dot, as is known, has a diameter of approximately 400 microns. This may be explained by the fact that the deviation of 1 cm as seen from the deflection point corresponds to a very small angle.

It has been previously stated that in the known method the red ball is eccentrically adjusted when the picture tube has a construction such that the landing triplets and the phosphor dot triplets are not congruent in the centre of the screen. A similar adjustment may alternatively be used in the method according to the invention. Figure 5 shows a phosphor dot triplet which is located in the centre of the screen the desired location of the landing spots being indicated. This Figure shows that the "red" landing spot must be centred around a point which is located down to the left at an angle of 30° relative to the horizontal line passing through the centre of the "red" phosphor dot. Since the purity must be adjusted in the centre of the screen, the landing must not be changed in that area due to the provision of coil 2. This means that coil 2 must in any case be centred around the centre C of the screen. The mentioned shift of the landing spot must be

added to the rotation caused by coil 2 which rotation is shown in Figure 3. Figure 3 shows that the shift and the rotation compensate each other in a point N which relative to the centre of the screen is shifted down to the right at an angle of 60° relative to the horizontal, in the 5 O'clock direction. Therefore, the centre of the red ball must be moved towards this point. This applies when the current flowing through coil 2 flows in the direction shown in Figure 3. If this current flows in the direction opposite thereto, the red ball must be shifted in the 11 O'clock direction. It is possible to place line 5 which serves as a template or another mark eccentrically in order that the red ball can be placed accurately relative thereto.

The described adjusting method is very simple. One person may perform this method with the aid of a mirror, while the deflection unit need only be shifted in so far as this is necessary to compensate for spatial tolerances. Inaccuracies in the adjustment of the purity, which might have been caused thereby, do not occur.

The greater accuracy of the method according to the invention as compared with the known red-ball method may be explained with reference to Figure 6 in which the reference numeral 4 denotes an electron beam which lands on centre C or at a point in the vicinity thereof. Electron beam 4 is first deflected in the plane P containing the purity magnets P whereafter this beam passes through point A in the deflection plane D and is again deflected there. The beam then reaches point C on which a satisfactory landing is obtained provided that it has passed through the correct deflection point A, that is to say, provided that it has been deflected in the plane P at the correct angle α . In the known red-ball method the purity magnets p are adjusted while deflection unit d is not in its correct position, that is to say, while the deflection plane is D' (Figure 6) in case of a retracted deflection unit. It is evident from Figure 6 that the beam must pass through point A if the red ball is to be obtained in the centre of the screen and therefore it must also pass through point A in plane D. This results in the purity magnets being adjusted erroneously because the obtained deflection angle in the plane P is larger than α . If the red ball were produced by moving the deflection unit forwards, the purity magnets would have been adjusted to a too small correction in a corresponding manner. Only when the deflection unit is in the exact axial position, which is the case in the microscope method and in the method according to the invention it is possible to adjust the purity magnets without errors.

It is clear from the foregoing that the deflection unit d must be placed very ac-

curately in the correct axial position (see Figure 2) if the colour purity is to be satisfactory. If this is not the case, the results as regards the deflection itself are very small because only the sensitivity of the deflection coils is slightly changed thereby, which may be compensated by varying the amplitudes of the deflection currents. In fact, the deflection unit is then almost, that is to say, but for a few mms in its optimum position. To place deflection unit d in the position required for the colour purity after purity magnets p are adjusted in the manner described, that is to say, after the purity is satisfactory in the centre of the screen, the following operations may be carried out. Unit d is moved axially until the reproduced colour on the entire screen is even and the exactness of the position found can be checked by putting a further electron beam or, which is more accurate, by putting the three electron beams into operation, for slight deviations are then visible as a discoloration.

The Philips publication already quoted (see Figure 6 of this publication) describes a more accurate method which, however, requires a microscope. According to one aspect of the invention a method to be preferred is therefore to move coil 2 horizontally, for example, to the left relative to the centre of screen 1. In Figure 7 coil 2 occupies the position which is denoted by the reference numeral 2'. A rotation of the landing spots occurs as was the case in Figure 3 but with the difference that this rotation is not symmetrical relative to the centre of coil 2' but is symmetrical relative to a point Q' which is located close to the axis of the picture tube. The electron beam impinging upon the screen at the area of the centre of coil 2' is in fact not parallel to the lines of force of the magnetic field generated by coil 2. If the deflection unit is in its correct position, the landing on point Q is satisfactory, in other words the red ball appears around this point Q' which point is located on the horizontal central line. Figure 8 shows a cross section of the picture tube seen from above, in which the solid line represents the electron beam impinging upon point Q' when deflection unit d is in its correct position. If this unit is moved too far towards the screen, the electrons follow the path which is shown as a broken line and they land to the left of point Q'. The same happens for all points which are present within coil 2'. A movement to the left is thus superimposed on the above-mentioned rotation, with the result that the red ball appears below point Q' if current i for coil 2 flows in the indicated direction. On the other hand, when the deflection unit is too far away from the screen, the red ball is noticeable above point Q'. Consequently, if

the red ball is centred around the point Q the mechanical securing means (Figures 2 and 8) of deflection unit d may be fixed. It may be noted that the adjustment of the purity magnets and the exact positioning of the deflection unit are then completely independent of each other.

The method described hereinbefore may be refined by using two similar coils 2 and 2'' and by placing them against the screen 1 as is shown in Figure 7. Two red balls are then observed which must be centred around the points Q' and Q'' located on the central horizontal line. When the deflection unit is moved, one red ball is moved upwards and the other is moved downwards if the current directions are those shown in Figure 7, which facilitates an accurate adjustment. If one of the currents flow in a direction which is relatively opposite to that shown in Figure 7, the two red balls are moved simultaneously upwards or downwards.

It may be noted that coils 2' and 2'' need not necessarily be located around the horizontal axis of the screen, but may alternatively be placed, for example, about the vertical axis or about a diagonal.

As is apparent from the Philips publication already mentioned, the landing spots and the phosphor dots must, however, not be concentric in the vicinity of points Q' and Q''. It may therefore occur that the deflection unit is exactly positioned for the "red" but not for the "green" colour purity. It is possible to adjust first for red, then for green and then again for red, which is not very practical. It may, however, be noted that the yellow ball which is produced when the "red" and the "green" electron guns are put into operation must be symmetrical relative to the vertical symmetry axis of the relevant phosphor dots. It is therefore more practical to make use of a yellow ball in one of the manners described with reference to the red ball.

The use of two coils 2 and 2'' as in Figure 7 has the drawback that a portion of the said coils protrudes beyond the edges of the screen 1 which in practice may have drawbacks or may even be impossible. Figure 9 shows a system of coils which is better in this respect and which consists of coils 2, 2' and 2'' and 2''' which are provided on a piece of cardboard of the same size as the screen while apertures are provided in the piece of cardboard through which the differently coloured balls can be observed. These apertures thus serve for the positioning of the coloured balls. Coil 2 serves for the adjustment of colour purity magnets p . Coils 2 and 2' for the accurate positioning of deflection unit d are substantially semicircular. However, since their electrical centre faces the centre of the

screen, the accuracy of this positioning would be less satisfactory because the influence of the position of the deflection unit is greatest where the deflection is greatest. For this reason, coil 2''' is provided through which a current flows whose direction as well as the direction of the current flowing through coil 2 amplifies the action of coils 2' and 2'' so that the red or yellow ball is located as closely as possible near the edge of the screen.

Figure 10 shows a circuit diagram of an arrangement by which the adjustment of the purity according to the invention may be performed. The circuit is equipped with four switches K_1 , K_2 , K_3 , and K_4 of which K_3 is an on-off switch. When switch K_1 is closed a constant direct voltage is produced across a Zener diode 6 which voltage is obtained by means of a rectifier circuit coupled to the mains supply. Simultaneously, this direct voltage is applied to the connections 3 of coil 2 for the adjustment of the colour purity magnets. For the adjustment of the axial position of the deflection unit this direct voltage is additionally applied through switch K_4 to the connections of coils 2', 2'', and 2'''. With this circuit which was employed for adjusting a 110° colour picture tube, coil 2 has a diameter of 20 cms while the magnetic strength was 60 ampere-turns. Coils 2' and 2'' likewise had a diameter of 20 cms and a magnetic strength of 135 ampere-turns while the magnetic strength of coil 2''' was 40 ampere-turns. After the colour purity is adjusted in the described manner, the shadow mask and possibly other metal parts of the picture tube must be degaussed because it has quite a considerable remanence as a result of the magnetic field generated by the coils. This may be performed in a simple manner by using the coils as degaussing coils. To this end switch K_2 is depressed after K_1 has been opened, so that the system of coils is switched to the mains voltage in series with a thermistor 7 having a positive temperature coefficient (PTC). After several seconds the circuit is switched off by means of switch K_3 . It is evident that the degaussing circuit of a television receiver incorporating the picture tube to be adjusted may alternatively be used so that thermistor 7 and switch K_2 may be omitted.

In the described method of adjusting the colour purity magnets and/or coils use was made of the "red" electron gun so that a red ball was produced. It is evident that a similar method may be used for the "green" or the "blue" electron gun. This also applies when adjusting picture tubes in which the landing triplets and the phosphor dot triplets are not congruent in the centre of the screen. When, for example, a green-ball method is used it follows from Figures 3 and 5 that the

green balls must be moved in the 10 O'clock direction in the case of the congruent direction being the one shown in Figure 3. Similar methods as the ones described are also usable if the phosphor dots are mutually arranged in a manner different from the manner shown in Figure 6 or, likewise as with the known red-ball method, when the electron beams are wider than the phosphor dots.

It is to be noted that the shape of coils 2, 2' and 2'' need not be limited to a circle and a semicircle, respectively. Coil 2 must only have a shape which is symmetrical relative to the centre C of the screen. The same effect, that is to say, the red ball, may alternatively be obtained when an annular permanent magnet instead of coil 2 is used, which magnet, need not be circular. In that case the circuit shown in Figure 10 is not required and degaussing cannot be effected other than by means of the relevant circuit in the television receiver. In order that the field generated by the magnet has the same properties as the field shown with reference to Figure 2, the magnet must be such that one annular side thereof is provided with similar magnetic poles. This similarly applies to the coils in Figure 9 which may alternatively be replaced by permanent magnets.

WHAT WE CLAIM IS:—

1. A method of adjusting the colour purity of a colour picture display tube the screen of which is provided with phosphor dots of luminescent material which when impinged upon by electron beams luminesce in different colours, the neck of said tube being provided with colour purity adjusting means and a deflection unit for deflecting the said electron beams, said method entailing the energising of at least one electron beam to illuminate said screen without any picture content, a pole of a device providing a magnetic field being placed on the face of said screen, said purity adjusting means being adjusted in such a manner that an area of the screen luminesces in the colour corresponding to the energised electron beam or beams in a previously determined position within the field.

2. A method as claimed in Claim 1, in which the said device is provided with marks corresponding to the said previously determined position between which marks the said area is positioned.

3. A method as claimed in Claim 1 or 2, in which in order to adjust the colour purity adjusting means only one electron beam is energised the magnetic field being symmetrical relative to a polar axis the said device being placed in such a manner that the polar axis of the device and the axis of the display tube substantially coincide, a

relevant mark being placed in the vicinity of the centre of the screen.

4. A method as claimed in Claim 2, in which near the centre of the said screen the centres of the electron beam landing spots must be shifted relative to the centres of the phosphor dots, a relevant mark being displaced relative to the centre of the screen in a direction which is perpendicular to a line connecting the centre of an adjusted landing spot of the energised electron beam to that of the relevant phosphor dot.

5. A method as claimed in Claim 3 when modified for adjusting the position of the deflection unit, in which the device is placed adjacent an edge of the screen in such a manner that it is substantially symmetrical relative to a symmetrical axis or a diagonal of the screen and that the relevant mark is placed on said axis or diagonal.

6. A method as claimed in Claim 1 or 2 when modified for adjusting the position of the deflection unit, in which two devices for providing magnetic fields are placed on a symmetrical axis of the screen in such a manner that the magnetic field generated within the picture display tube causes an area of the screen which luminesces in the said manner to be produced on either side of the said axis, relevant marks being placed on the said axis.

7. Apparatus for performing the method as claimed in any of the preceding Claims, in which the device for providing the magnetic field is a coil through which a direct current flows, the diameter of said coil being greater than its winding depth.

8. Apparatus for performing the method as claimed in any of Claims 1 to 6, in which the device for providing the magnetic field is a substantially annular permanent magnet one annular side of which is of uniform polarity.

9. Apparatus as claimed in Claim 7, in which the display tube is a shadow mask tube, the said coil also functioning as a degaussing coil for degaussing the shadow mask and surrounding metal parts of the display tube.

10. Apparatus as claimed in Claim 9, including a source providing the direct current for said coil, a thermistor having a positive temperature coefficient and a switch for connecting the coil in series with said thermistor, the series arrangement when formed being energised from an alternating voltage source.

11. A method of adjusting the colour purity of a colour picture display tube, substantially as herein described with reference to the accompanying drawings.

12. Apparatus for adjusting the colour purity of a colour picture display tube, substantially as herein described with reference to the accompanying drawings.

C. A. CLARK,
Chartered Patent Agents,
Century House,
Shaftesbury Avenue,
London, W.C.2.
Agent for the Applicants.

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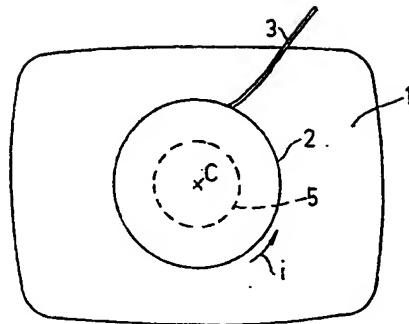


Fig.1

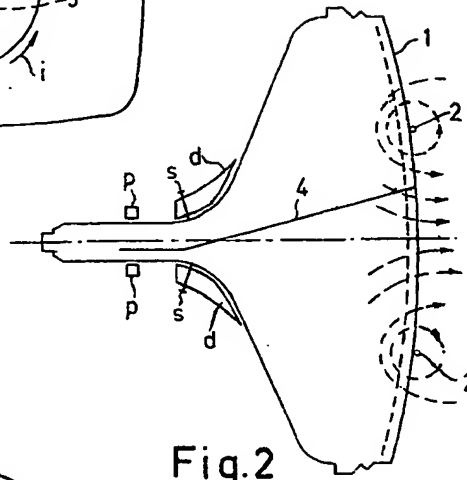


Fig.2

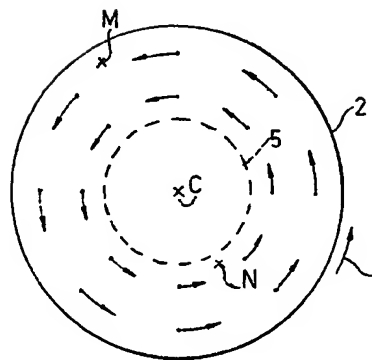


Fig.3



Fig. 4a

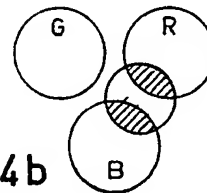


Fig.4b

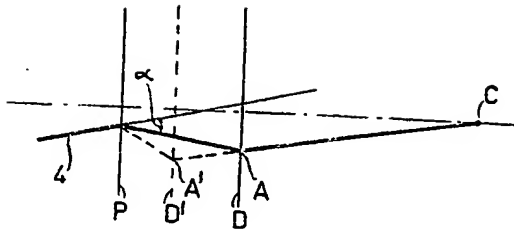


Fig. 6

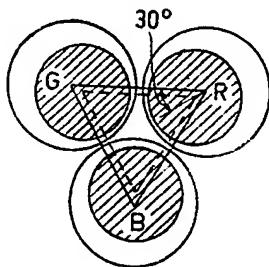


Fig. 5

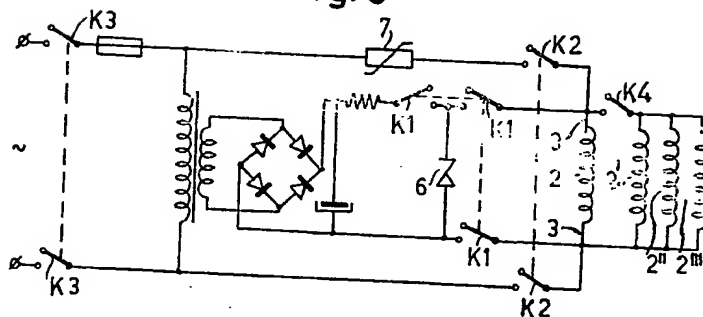


Fig. 10

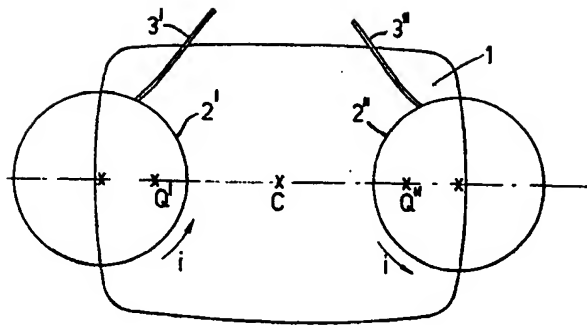


Fig. 7

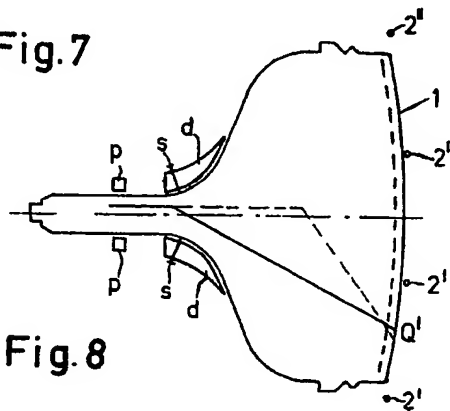


Fig. 8

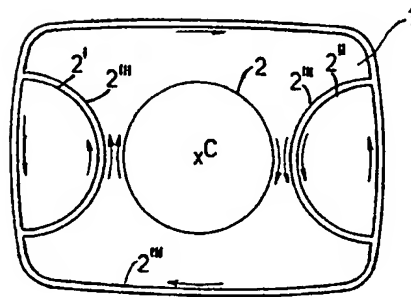


Fig. 9